

CALLUM VINCENT

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# ULTRAFAST LASER HEATING





# EXETER CDT

EPSRC Centre for  
Doctoral Training  
in Metamaterials

$XM^2$

EPSRC

Engineering and Physical Sciences  
Research Council

UNIVERSITY OF  
EXETER



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# ULTRAFAST LASER HEATING

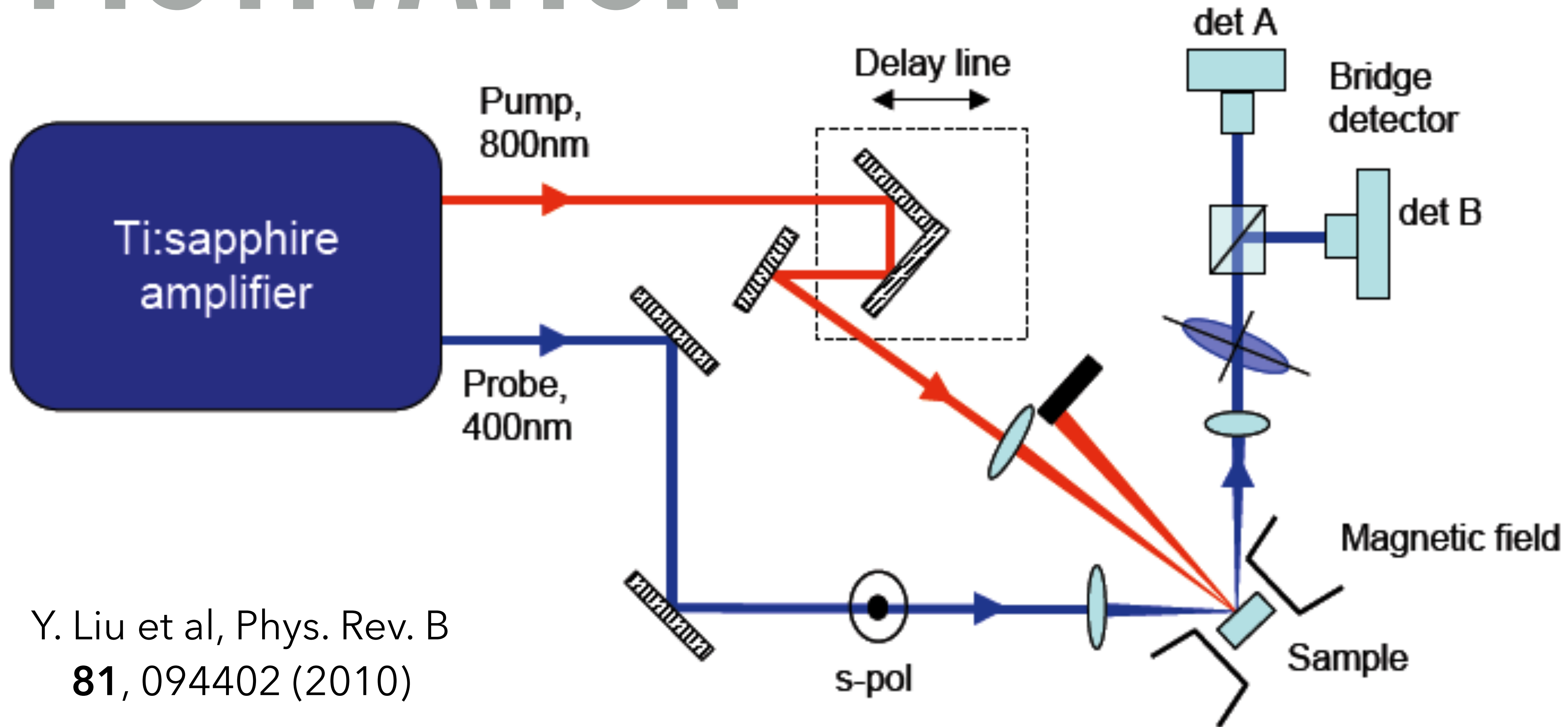
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**ULTRAFAST LASER HEATING**

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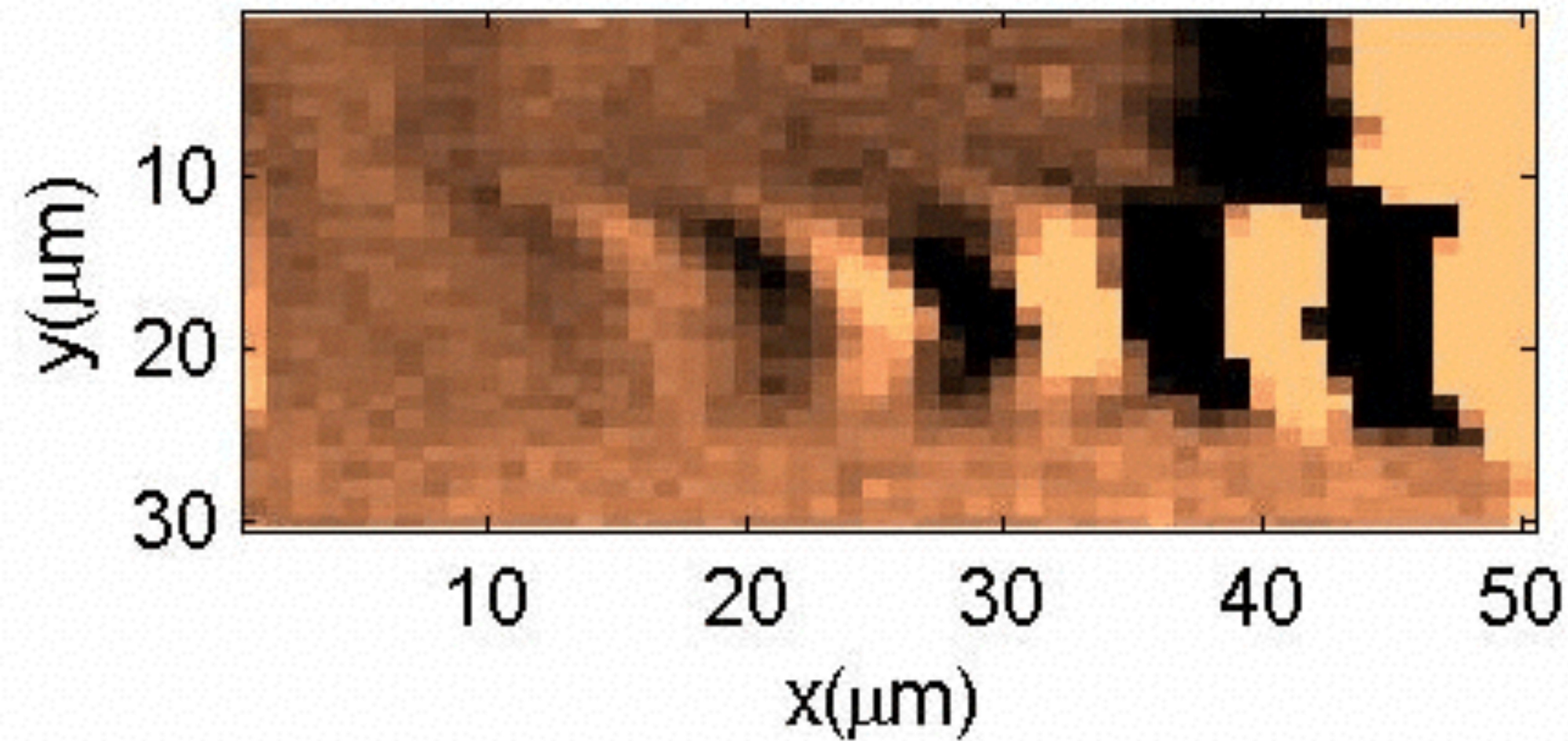
# MOTIVATION



Y. Liu et al, Phys. Rev. B  
**81**, 094402 (2010)



kerr signal



**HEAT + MAGNETISM = ?**



**HEAT** + **MAGNETISM** = ?



# HEAT EQUATION

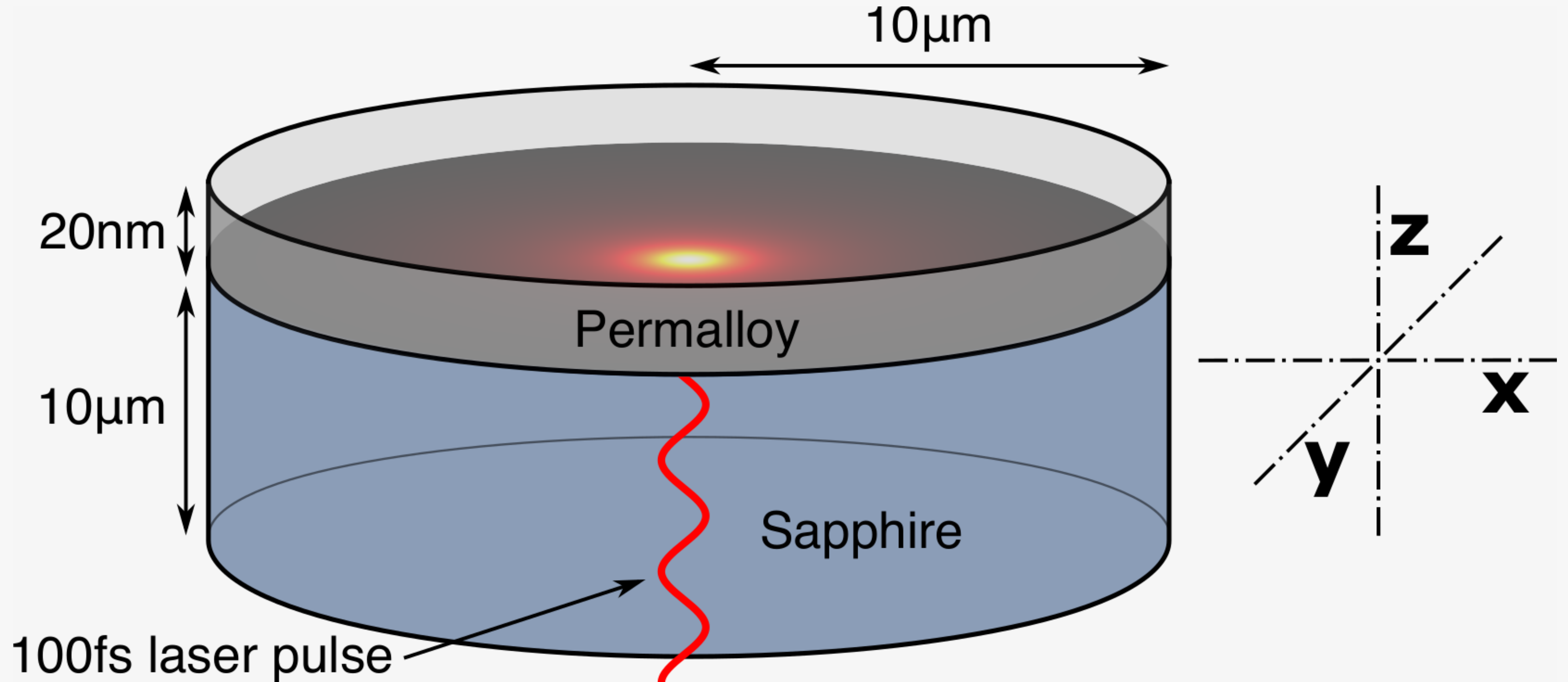
$$\rho c_p \frac{\partial T}{\partial t} = \kappa \nabla^2 T + Q$$

# HEAT SOURCE

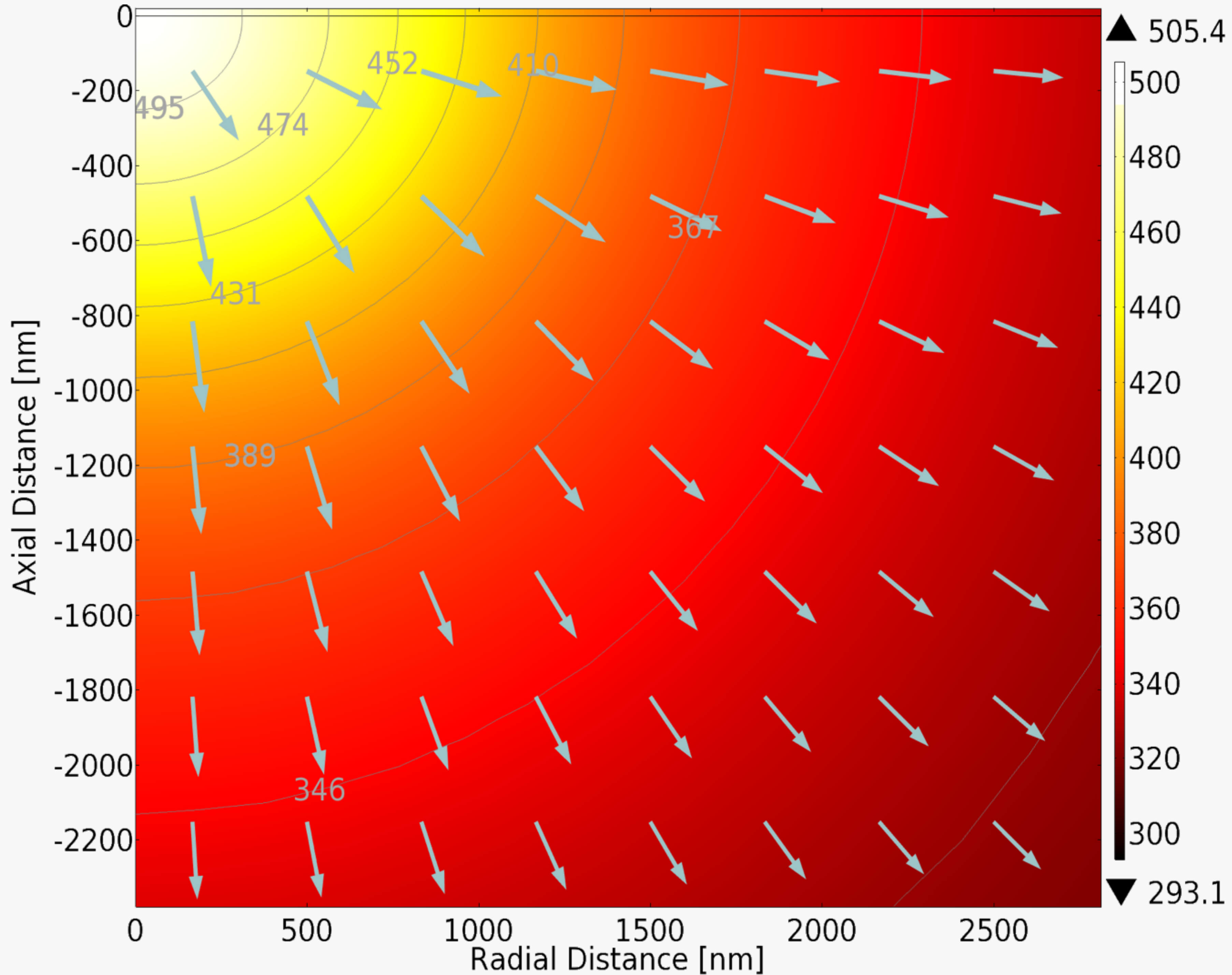
$$G(r) \times G(t) \times e^{-z}$$



# THE SAMPLE

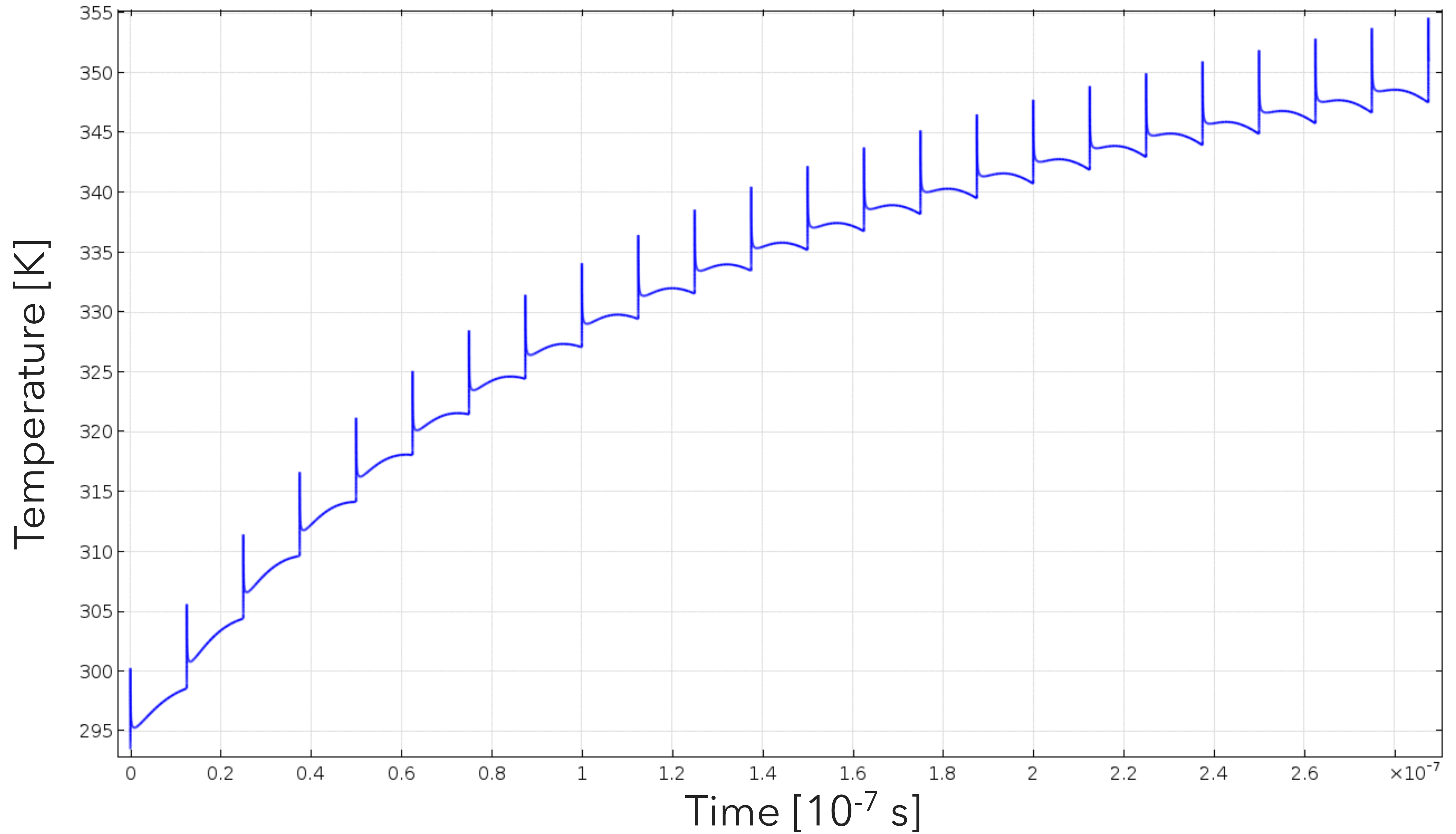


# NUMERICAL MODEL

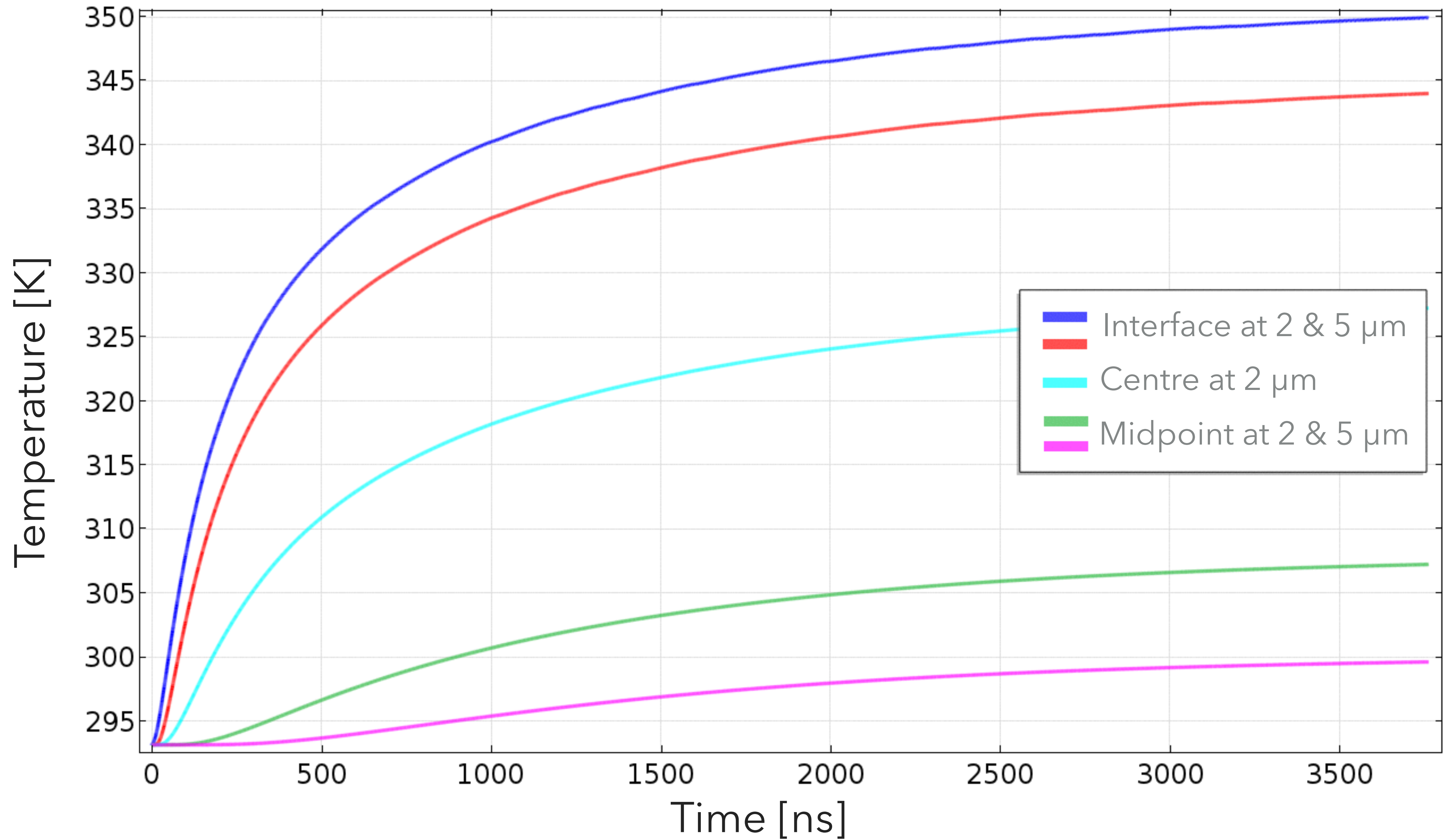




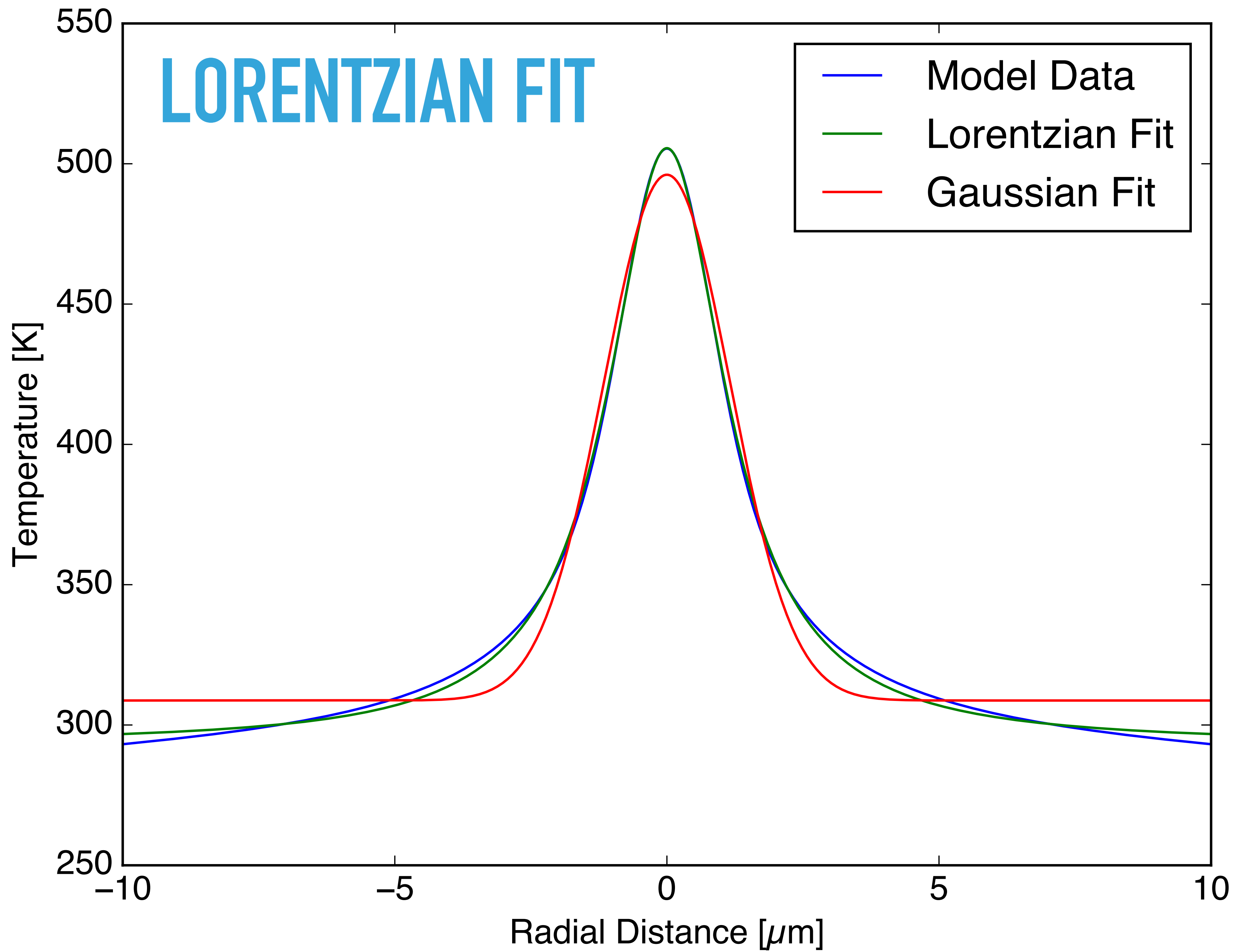
# 30 Pulses at 1.5 $\mu\text{m}$



# After 300 Pulses







**HEAT + MAGNETISM = ?**



HEAT + MAGNETISM = ?

HEAT + MAGNETISM = ?



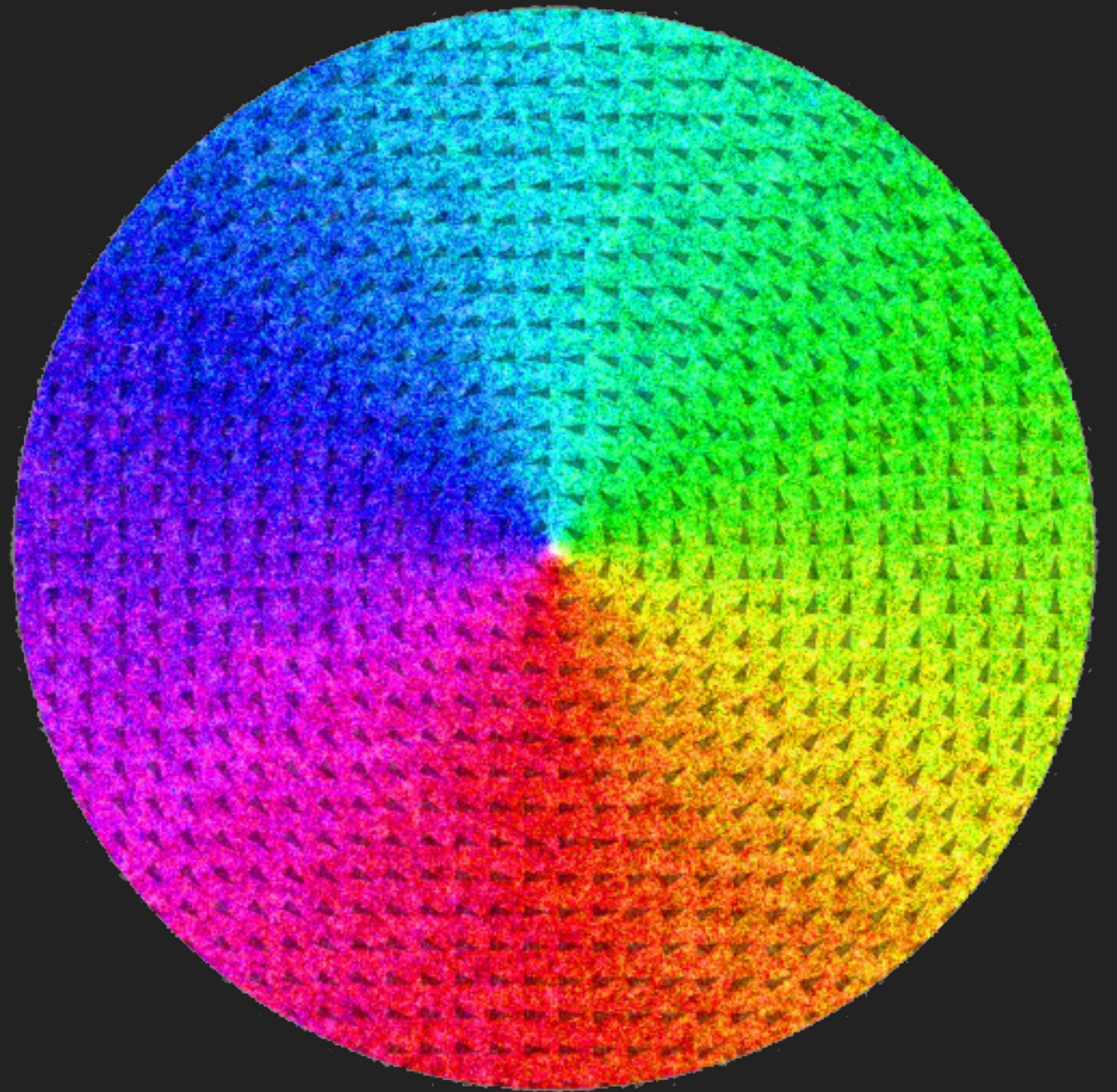


# **mumax3**

GPU-accelerated micromagnetism



**NOT  
JUST  
RANDOM**

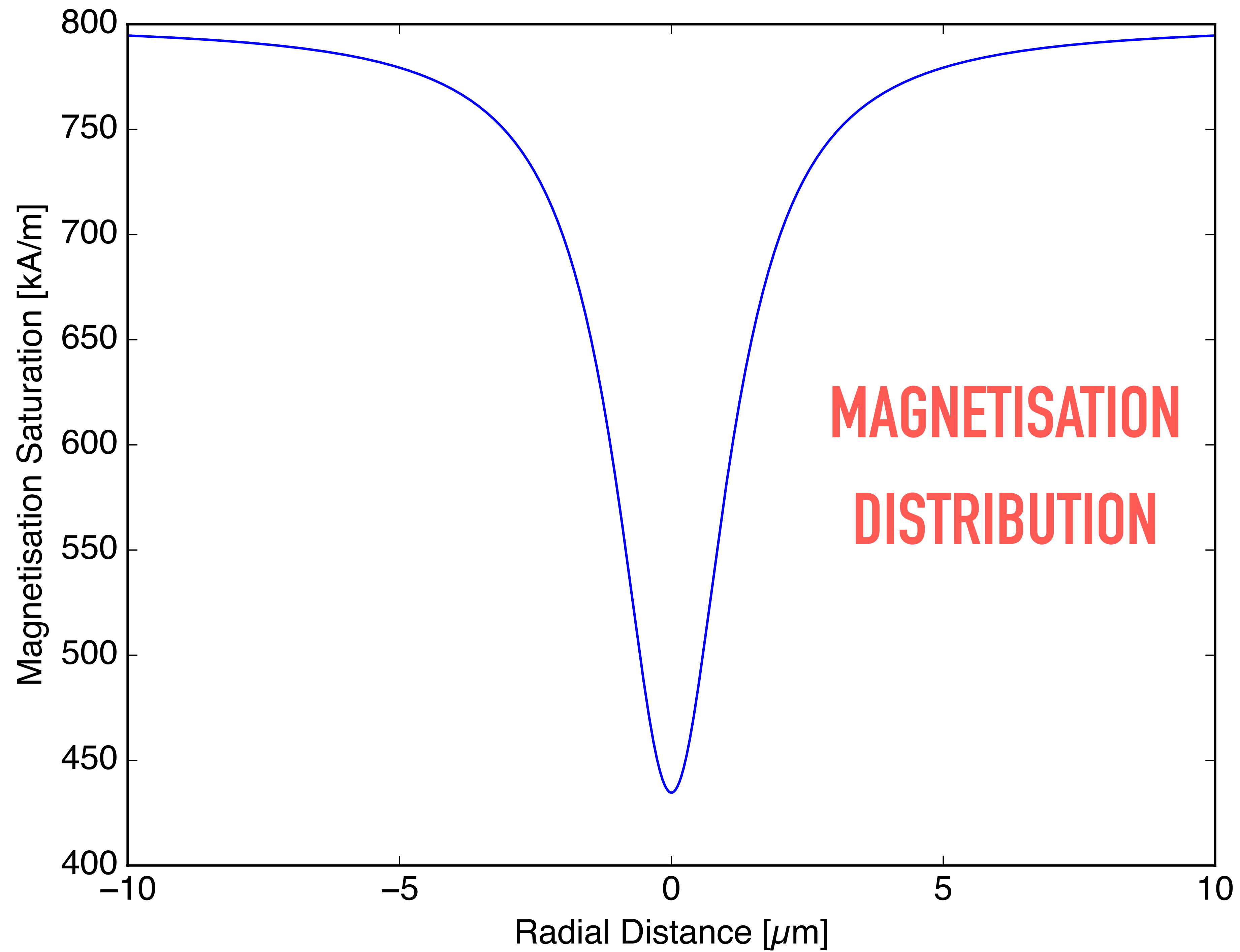




# REDUCED MAGNETISATION

$$M_s(T) = M_s(0) \left( 1 - (T/T_c)^{\frac{3}{2}} \right)$$





# MAGNETISATION DISTRIBUTION



HIGH

LOW



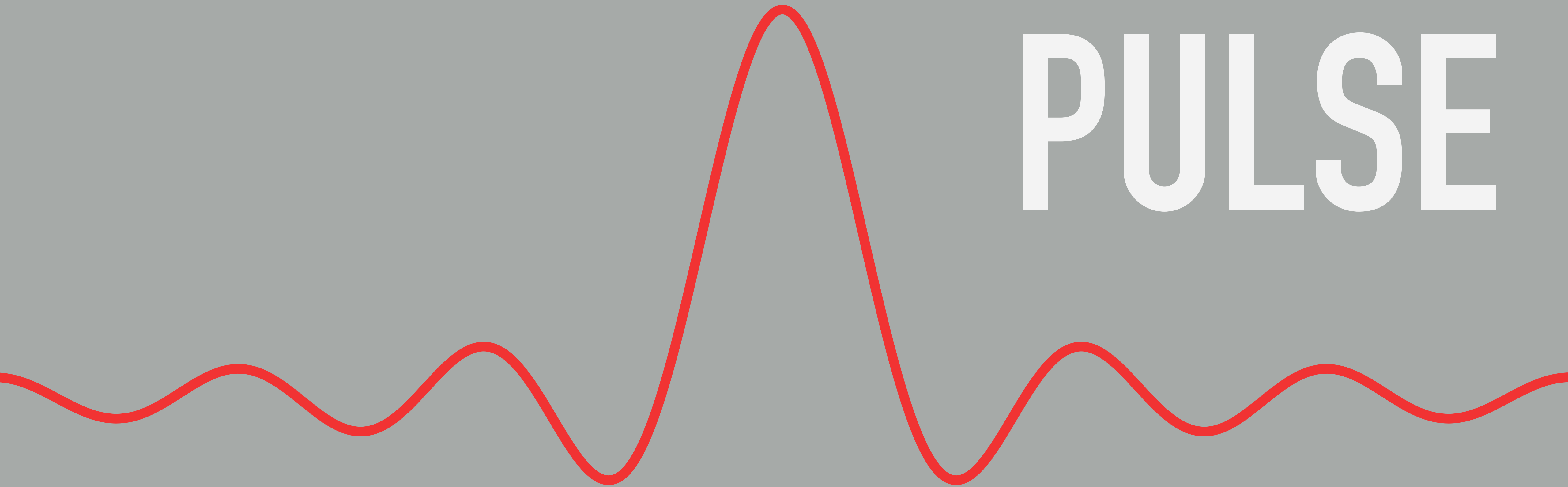
LETS  
RELAX



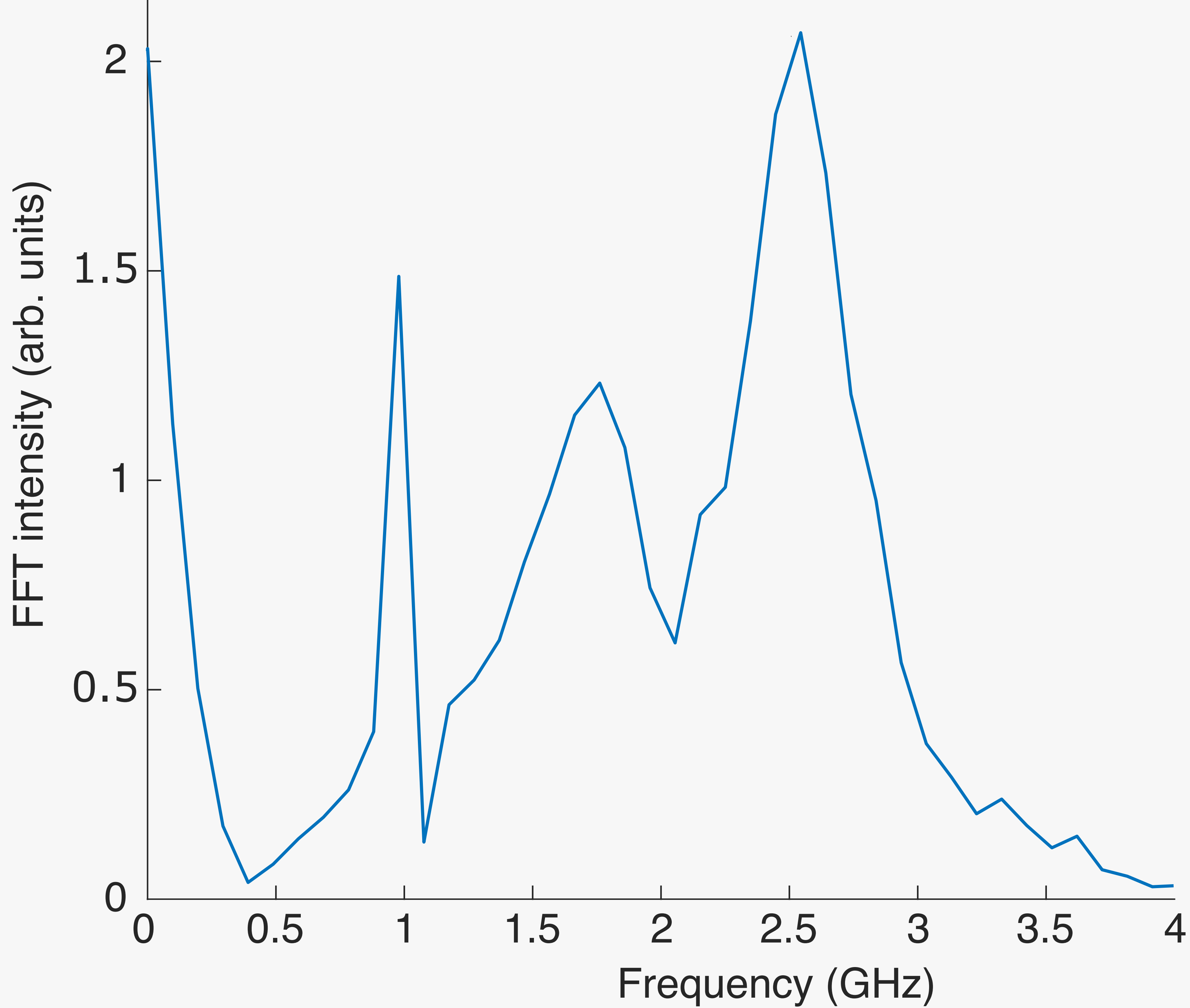
Bias



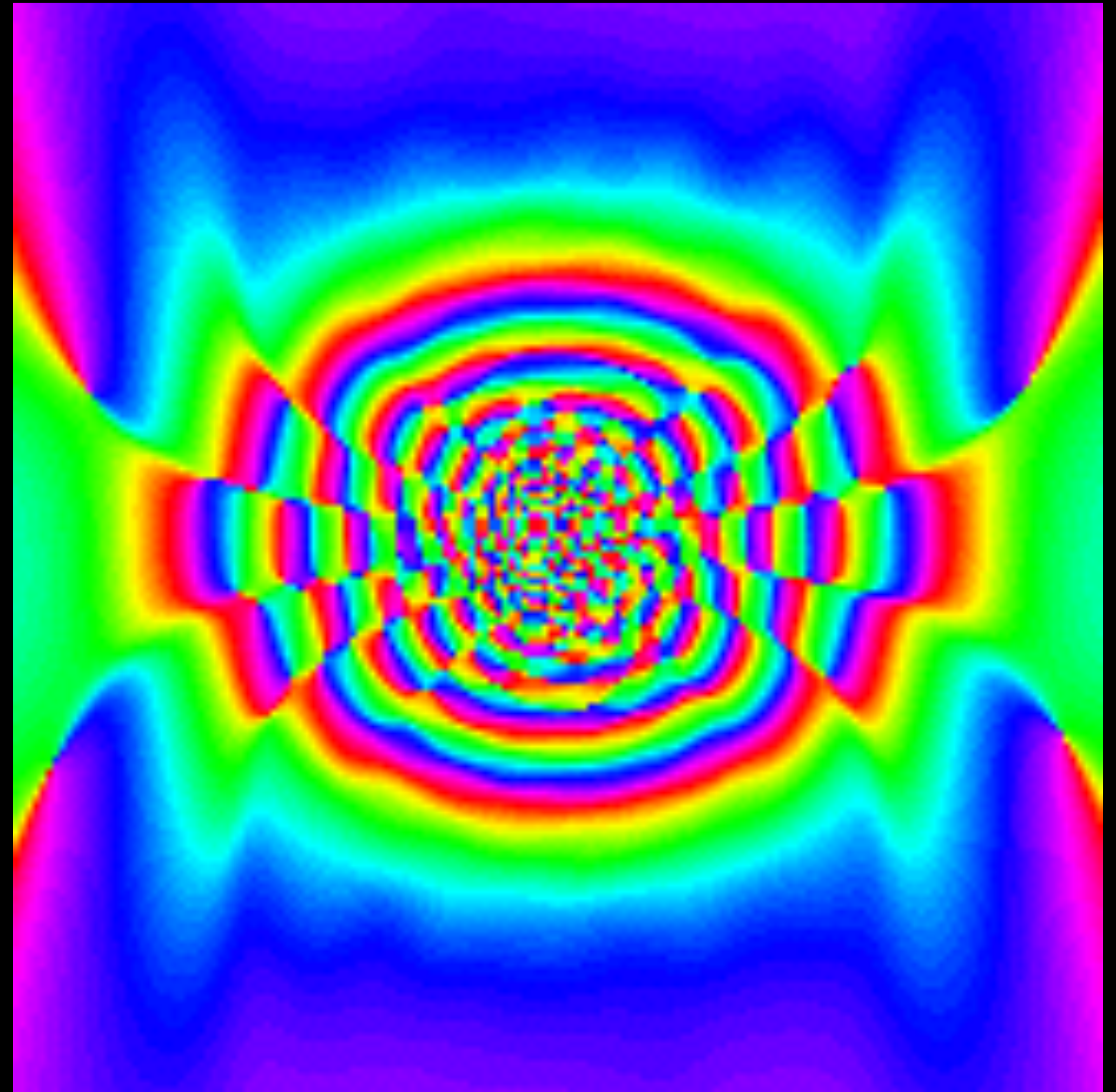
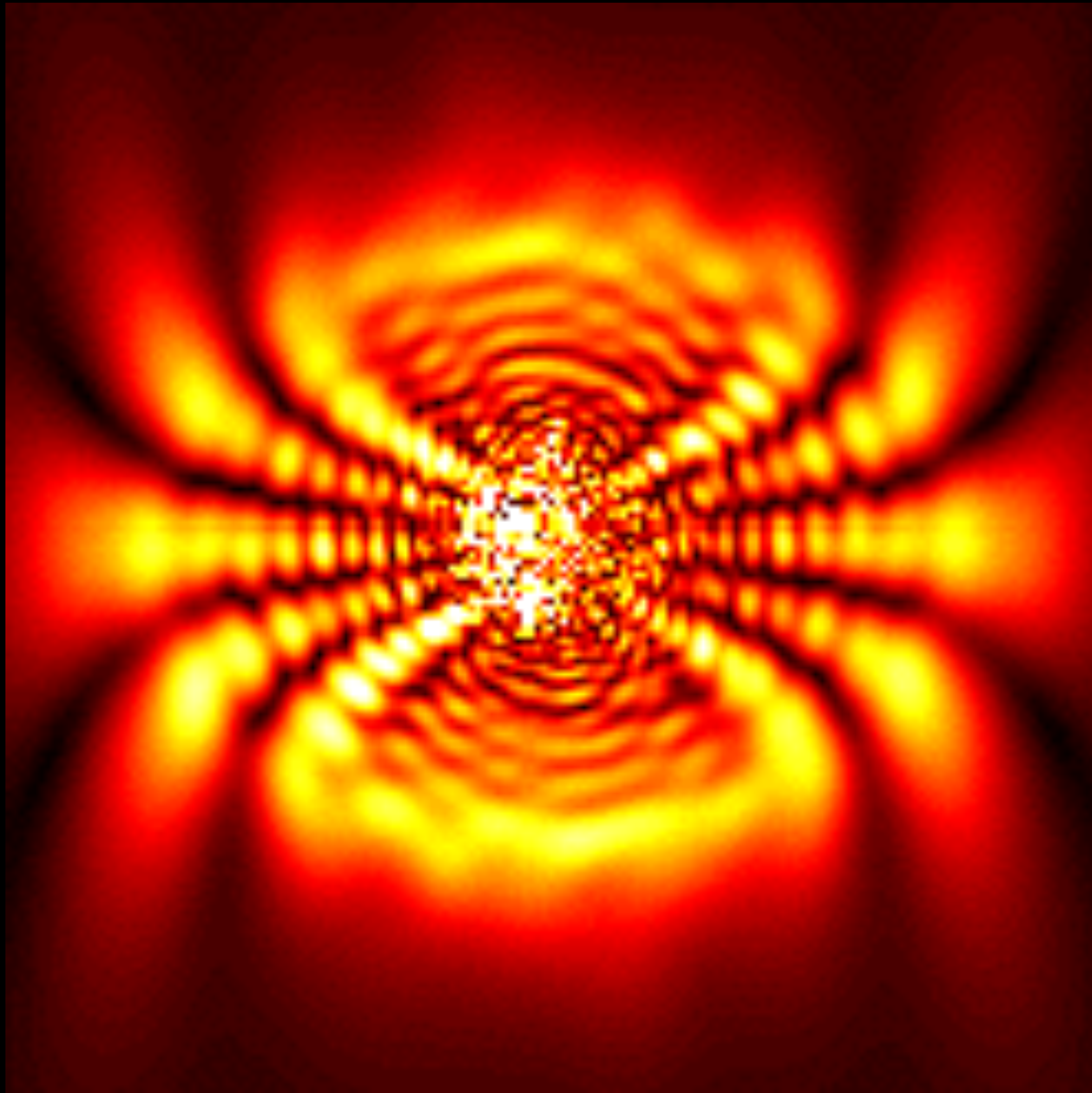
# AND PULSE



# SPECTRUM

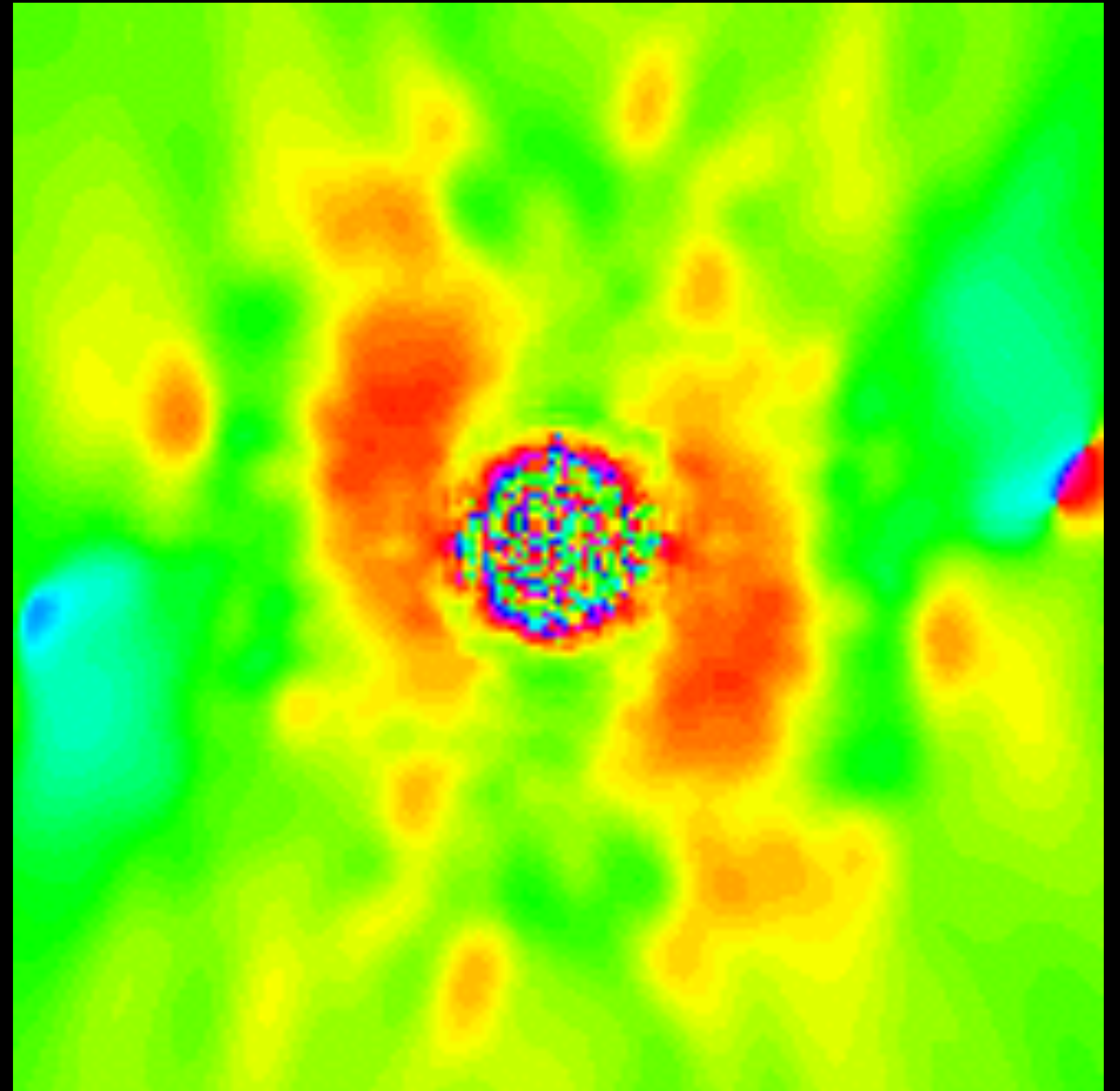
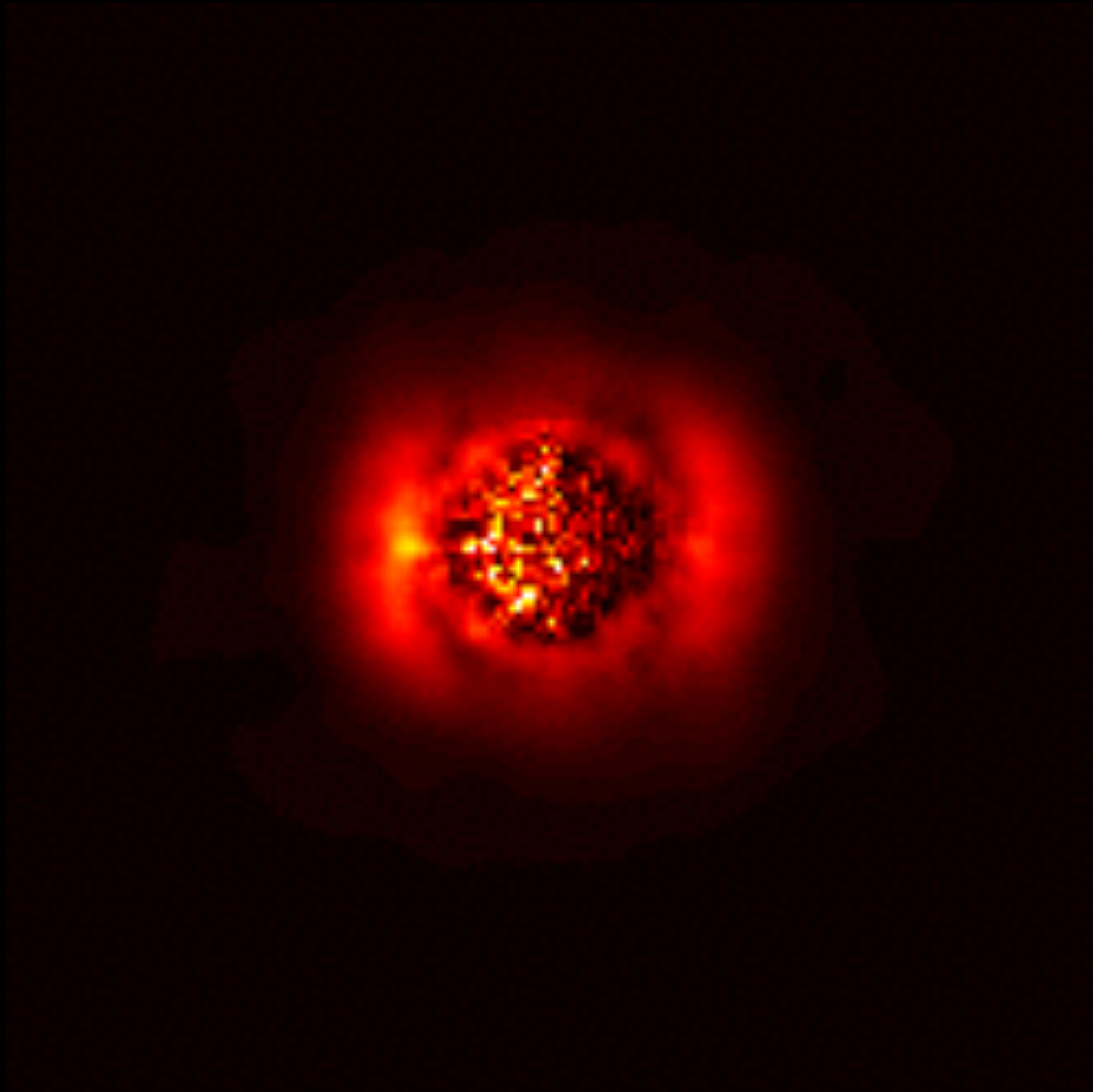


# PROPAGATING



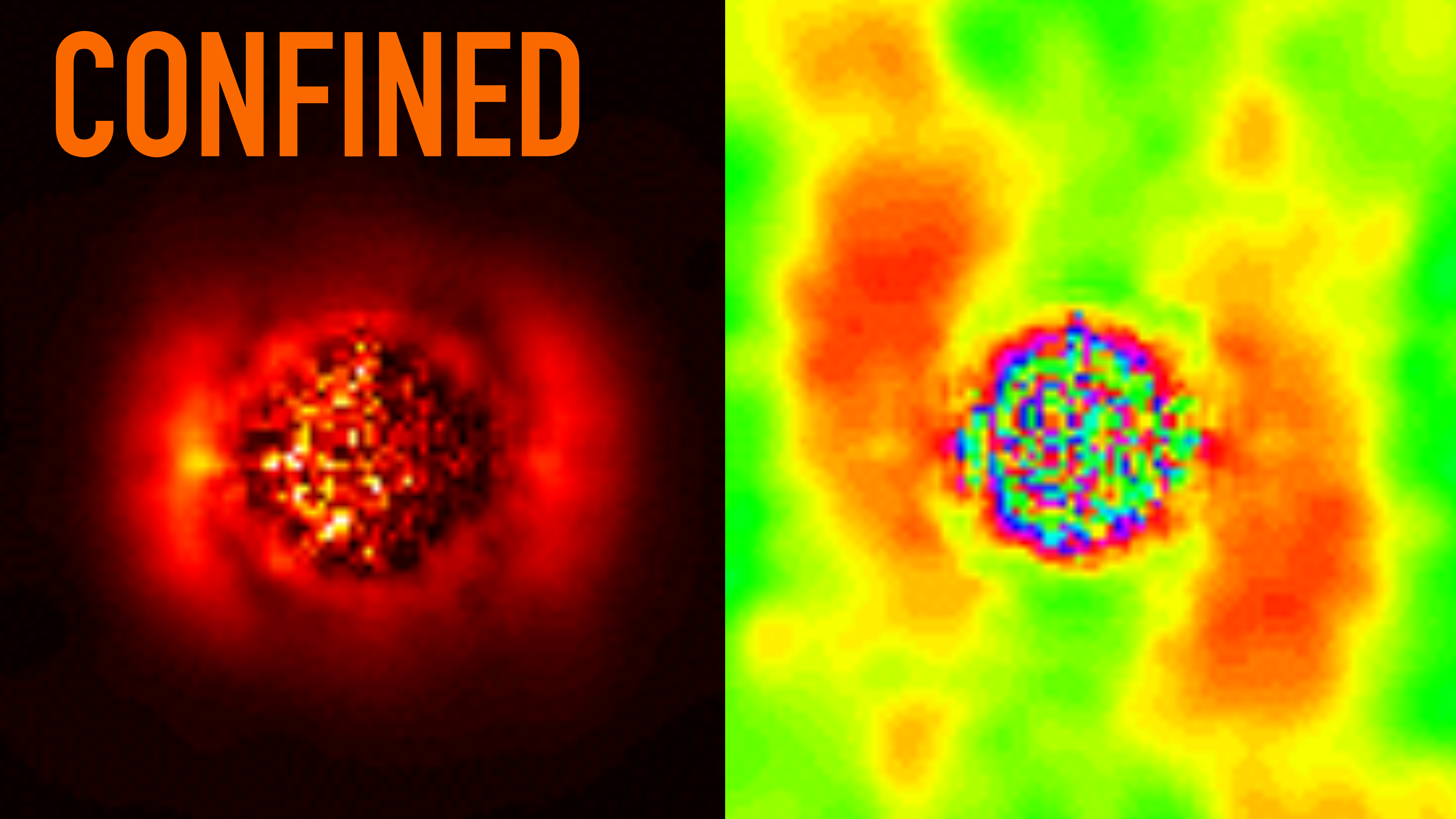


# CONFINED





# CONFINED



# CONCLUSIONS

- ▶ Ultrafast lasers, heating is significant
- ▶ Temperatures  $> 500\text{K}$
- ▶ Magnetisation saturation distribution produces propagating and confined modes

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**ULTRAFAST LASER HEATING**



# THANK YOU!

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